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Qualcomm

C-V2X deployment: continuing the momentum in 2021

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Our focus areas

Telematics & C-V2X

3G → 4G → 5G

Qualcomm® Snapdragon™ Automotive 4G/5G Platforms

Integrated precise positioning, Wi-Fi 6, BT5.1

Snapdragon telematics co-processor

C-V2X Technology

Digital Cockpit

Snapdragon Automotive Cockpit SoCs

IVI, Cluster, Passenger and Rear Seat entertainment

Driver and occupant monitoring

Virtualized and containerized RTOS/OSes
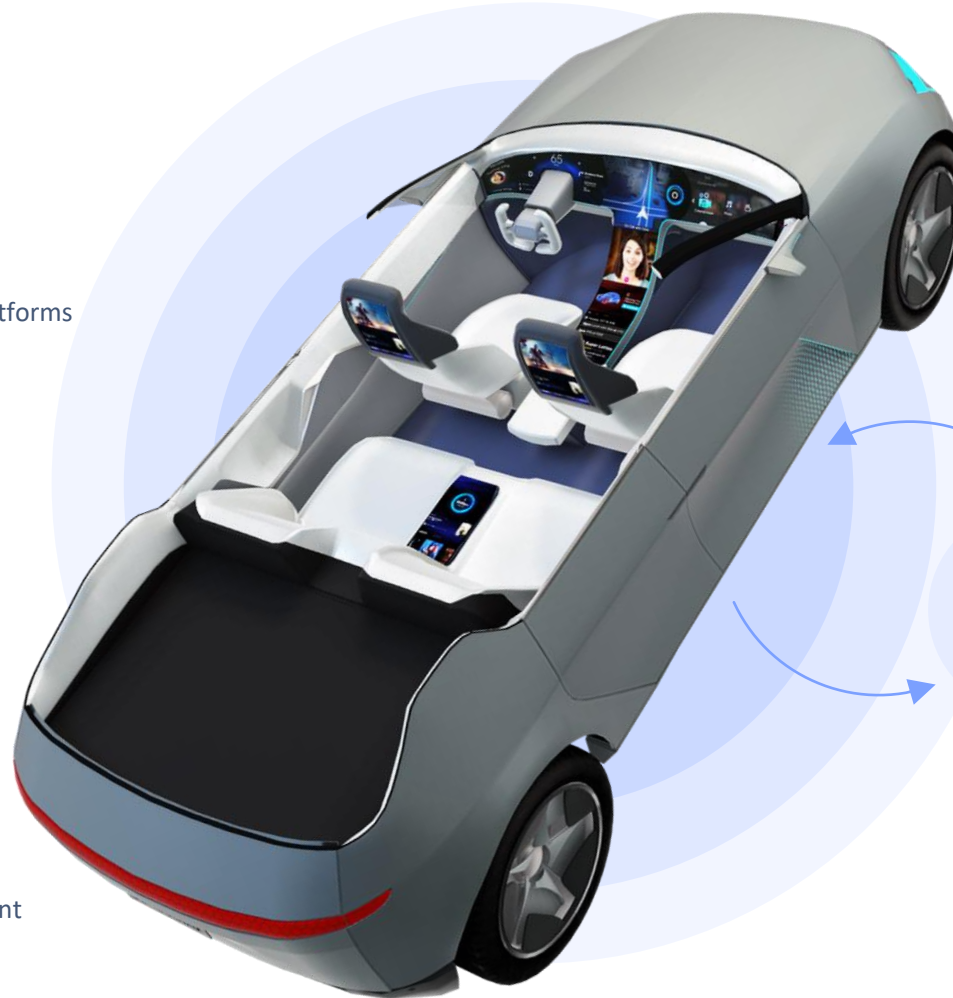
ADAS & autonomous driving

Scalable portfolio from L1 NCAP to L3 SoCs

Safety Accelerator for L4/L5 autonomous driving

Open and programmable ADAS stack

Safety software platform, HIL/SIL Toolchain
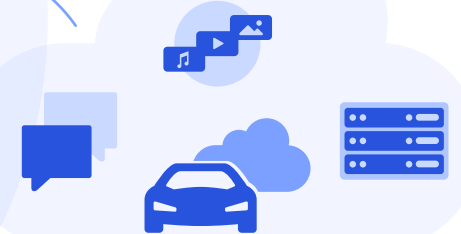
Qualcomm® Car-to-Cloud Platform

Cloud connectivity

OTA updates

Feature and SKU management

Apps, Content, Services, Productivity

Telematics: Connected Car

Connectivity key drivers:

Ubiquitous network connectivity, MF-GNSS, DSDA, C-V2X, Scalability, Integration

5G

- Multi-Gigabit speeds
- Ultra Low latency (TCU Apps)

- 5G/4G Scalability
- Ubiquitous coverage over lifetime

- Global RFFE attach
- Extended lifetime

- Integration
- Telematics SDK

5G **4G**

- Multi-Gigabit speeds
- Ultra Low latency (TCU Apps)

- 5G/4G Scalability
- Ubiquitous coverage over lifetime

- Global RFFE attach
- Extended lifetime

- Integration
- Telematics SDK

5G

Accelerating globally:

160+
Operators with 5G commercially deployed

65+
Countries globally

270+
Additional operators investing to deploy 5G

and in Europe:

75+
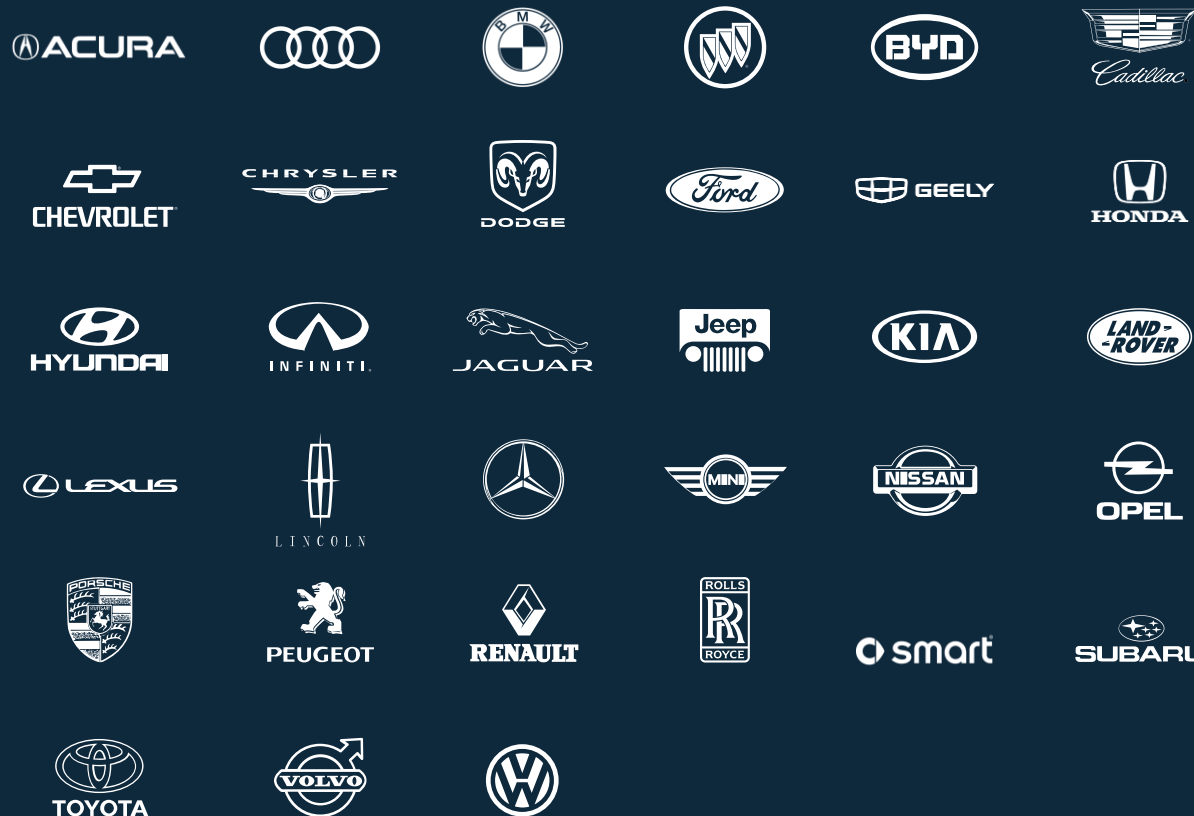Operators with 5G commercially deployed In Europe

30
Countries in Europe

65+
Additional operators in Europe investing to deploy 5G

World's Leading Automakers build with our solutions

ACURA · AUDI · BMW · BUICK · BYD · CADILLAC

CHEVROLET · CHRYSLER · DODGE · Ford · GEELY · HONDA

HYUNDAI · INFINITI · JAGUAR · Jeep · KIA · LAND-ROVER

LEXUS · LINCOLN · MERCEDES · MINI · NISSAN · OPEL

PORSCHE · PEUGEOT · RENAULT · ROLLS ROYCE · smart · SUBARU

TOYOTA · VOLVO · VW

#1

in telematics and Bluetooth for automotive

150+ million

vehicles connected with Qualcomm Technologies modems

22

Of top 25 automakers have selected the Snapdragon Automotive Cockpit Platform

$9B

Design-win pipeline for telematics, infotainment, and in-car connectivity

Telematics & Connected Services

Digital Cockpit & In-Vehicle Experiences

Autonomous Driving & Road Safety

V2X is a critical component to our vision
Giving vehicles the ability to communicate with each other and beyond

Vehicle-to-infrastructure (V2I)
e.g. traffic signal timing / priority

Vehicle-to-network (V2N)
e.g. real-time traffic / routing, cloud services

Vehicle-to-vehicle (V2V)
e.g. collision avoidance safety systems

Vehicle-to-pedestrian (V2P)
e.g. safety alerts to pedestrians, bicyclists

C-V2X

Established the foundation
of C-V2X for safety in Rel-14/15
with continued evolution in Rel-16 5G
NR for advanced use cases

Enhanced range
and reliability for direct
communication without
network assistance

V2V
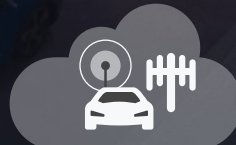Vehicle-to-vehicle
e.g., collision avoidance safety systems

V2I
Vehicle-to-infrastructure
e.g., traffic signal timing/priority

V2P
Vehicle-to-pedestrian
e.g., safety alerts to pedestrians,
bicyclists

V2N
Vehicle-to-network
e.g., real-time traffic/routing, cloud services

☑ Release 14/15/16 C-V2X standards
completed (V2V, V2I, V2P)

Broad industry support with 5GAA

Global trials started in 2017

Qualcomm® 9150 C-V2X chipset
announced in September 2017

Integration of C-V2X into the Qualcomm®
Snapdragon™ Automotive 4G (SA415M) and
5G (SA515M) Platforms announced in 2019

C-V2X enables network independent communication

Direct safety communication independent of cellular network

Low latency Vehicle to Vehicle (V2V), Vehicle to Infrastructure (V2I), and Vehicle to Person (V2P) operating in ITS bands (e.g. 5.9 GHz)

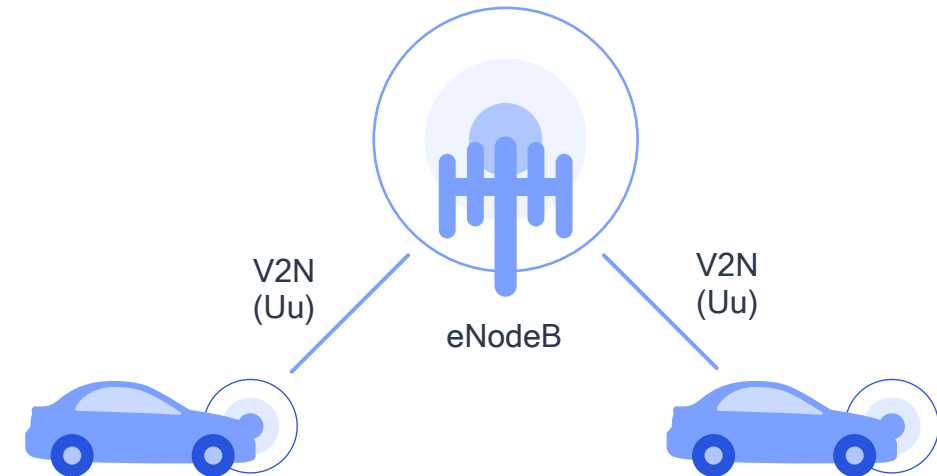### Direct PC5 interface

e.g. location, speed, local hazards

V2I (PC5) V2I (PC5)

RSU[1]

V2V (PC5)

V2P (PC5) V2P (PC5)
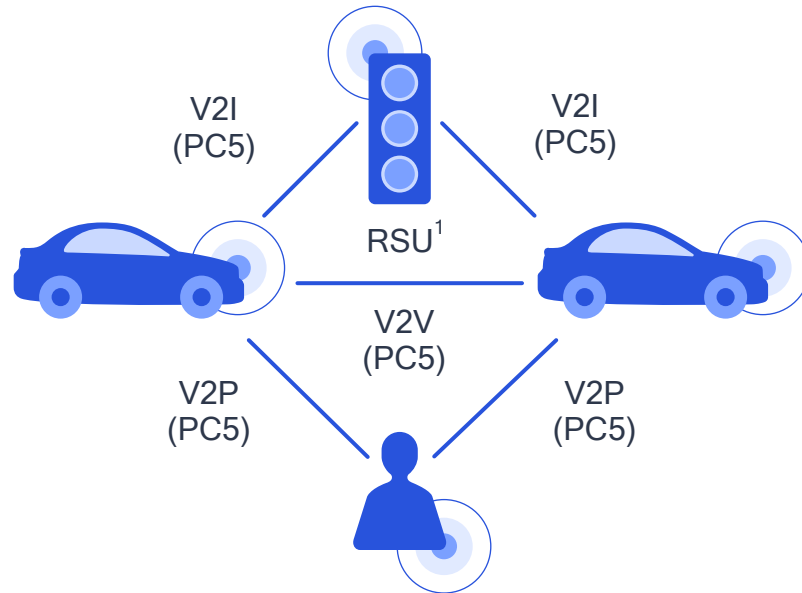
Network communications for complementary services

Vehicle to Network (V2N) operates in a mobile operator's licensed spectrum

Network Uu interface

e.g. accident 2 kilometer ahead

V2N (Uu) eNodeB V2N (Uu)

C-V2X is designed to work without network assistance

Auto OEMs do not want to be tied to a network

USIM-less operation

Direct communication doesn't require USIM

Autonomous resource selection

Scalable distributed scheduling, where vehicles selects resources without network assistance
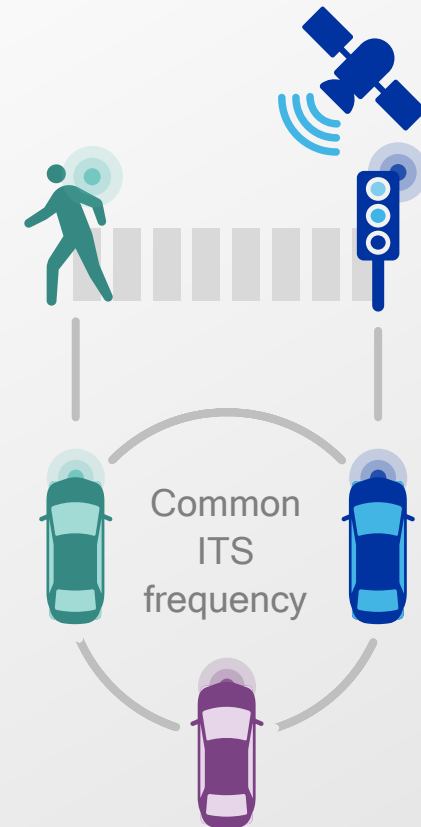
GNSS time synchronization

GNSS used for time synchronization without relying on cellular networks

5.9 GHz ITS band support

High speed direct communication support add for ITS band

Reuse established service & app. layer

Defined by ISO, ETSI, SAE for security and transport layer

Common ITS frequency

Direct communications
(via PC5 interface on 5.9GHz)

C-V2X started with R-14; Evolving to support autonomy

2017 — 2018 — 2019

Support autonomy
C-V2X R16 NR (backward compatible with R14/15)

Safety C-V2X R14 (LTE)

Further Safety Enh.
C-V2X R15 (LTE)
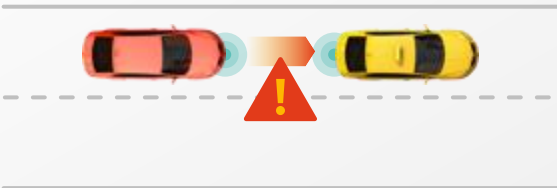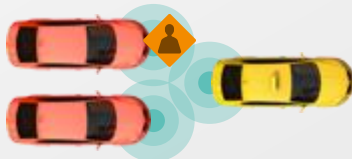
Higher reliability

Lower latency

Higher throughput

Wideband ranging and positioning

Higher throughput

Lower latency

Sensor sharing simplifying perception

Forward collision warning
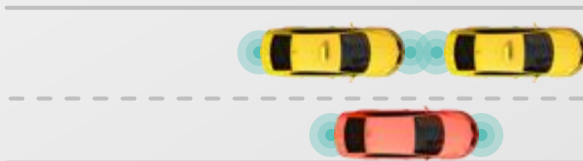
Cooperative ranging/positioning

Bird's eye view / HD map updates

NR C-V2X builds on LTE C-V2X
with advanced use cases

Safety use cases

Advanced use cases

Upper layers
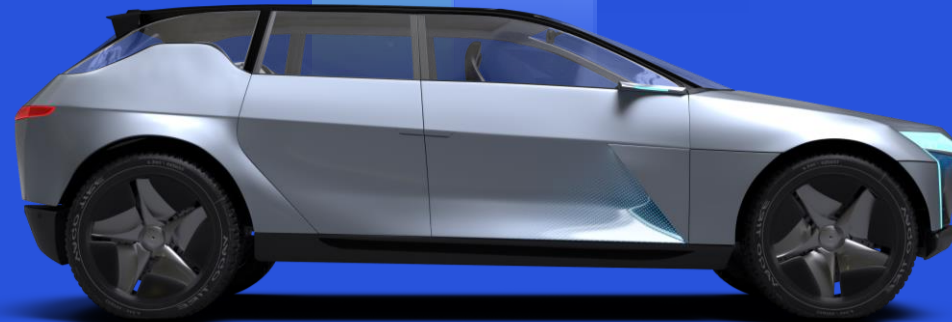Mapping use cases to transport profile

+

C-V2X
Rel 14/15 sidelink
Broadcast messages

NR C-V2X
Rel 16+ sidelink
Multicast messages

5G C-V2X sidelink

NR C-V2X introduces complementary capabilities for advanced use cases

Rel 14 C-V2X only car

Rel 14 / 15 C-V2X for automotive safety

C-V2X R14 PC5

Automotive safety
Forward-collision warning

Rel 14 / Rel 16+ C-V2X

C-V2X R14 PC5

R14 / R16+ C-V2X

Advanced use cases for all vehicles

Autonomous driving

C-V2X R14 / R16+ PC5

Rel 16+ NR C-V2X vehicles are designed to support Rel 14 / 15 for safety use cases

5G

C-V2X evolution towards autonomy support

C-V2X can significantly help autonomy
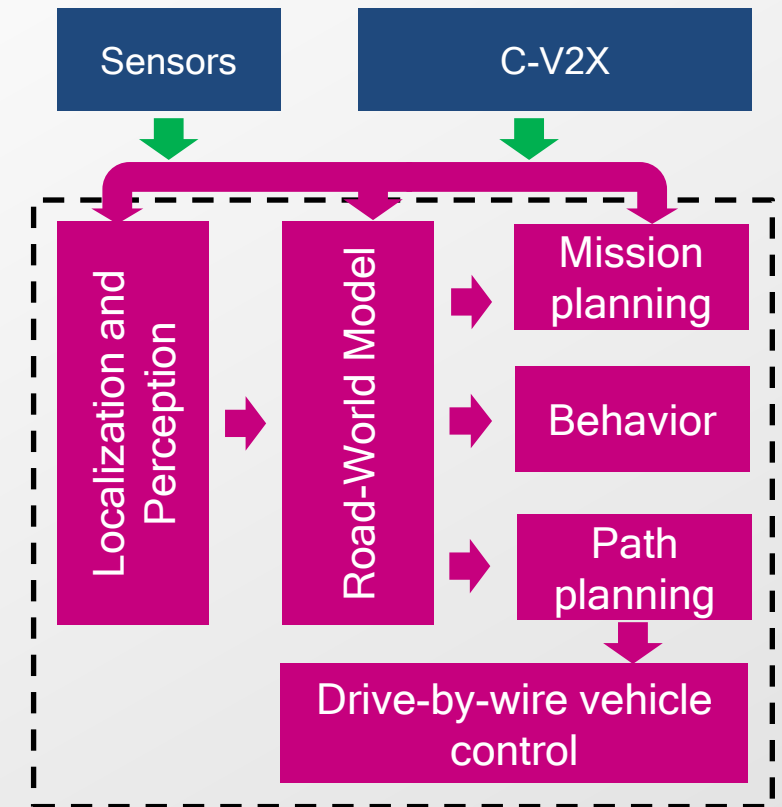
- ## Localization

  C-V2X based ranging to enhance positioning
  Local HD MAP generation and update

- ## Perception

  C-V2X as a sensor for N-LOS object detection
  C-V2X to share sensor information between vehicles

- ## Behavioral planning

  Communication of motion plans between vehicles to enhance robustness

Higher reliability   **Higher throughput**   **Lower latency**   **Ranging**

C-V2X

Concurrent operation with WWAN

MF-GNSS

Highest Precision lane-level location and positioning

Increased safety & security complemented by WAN

Continental   GosuncWelink   LG   Quectel   Rolling Wireless   WNC   ZTE

Over 150M+ cars on the road with Qualcomm Technologies modems

| 2000 | | 2010 | 2013 | | | 2017 | 2019 | 2021 | 2022 |

MSM 5105 | MSM 6x00 | QSC 6270 | MDM 8215 9x15 | MDM 9x28 9x30 | MDM 9x40 9x50 | MDM 9150 (CV2X) | SA415M | SA515M

#1 in Telematics

Telematics & Connected Services

Strong momentum for C-V2X globally in 2020, especially in China:

"New 4 layers" testing with 100+ C-V2X industry entities, including 26 auto OEMs

Commercially, Qualcomm Technologies has won over 16 C-V2X design wins in 2020

BUICK   gm   长城汽车 Great Wall Motors   红旗 让理想飞扬 HONGQI New HongQi, New Dream   NIO

在V2V演示中，车辆之间会以广播形式共享自身状态信息，例如：故障车辆会向附近车辆发送信息
In the V2V scenario, vehicles share information about their own status through broadcasting, for instance, an abnormal vehicle will send messages to vehicles in the vicinity

异常车辆24m

35 km/h   故障车辆提醒 Abnormal Vehicle Warning

ANAS C-V2X deployment in Italy

- First deployment of the announced Smart Road project, an ambitious plan to create 3000km of intelligent roads in Italy with an investment of 1B euro

- 81Km of Highway 51 to Cortina, the famed ski resort town

- Covered by dual-mode C-V2X/G5 RSUs

http://www.anaspercortina2021.it/

ANAS C-V2X

Smart Pole with modular design supporting multiple technologies

1. Dual mode C-V2X / G5 RSU

2. Wi-Fi in motion

3. Smart Camera

4. Led Light
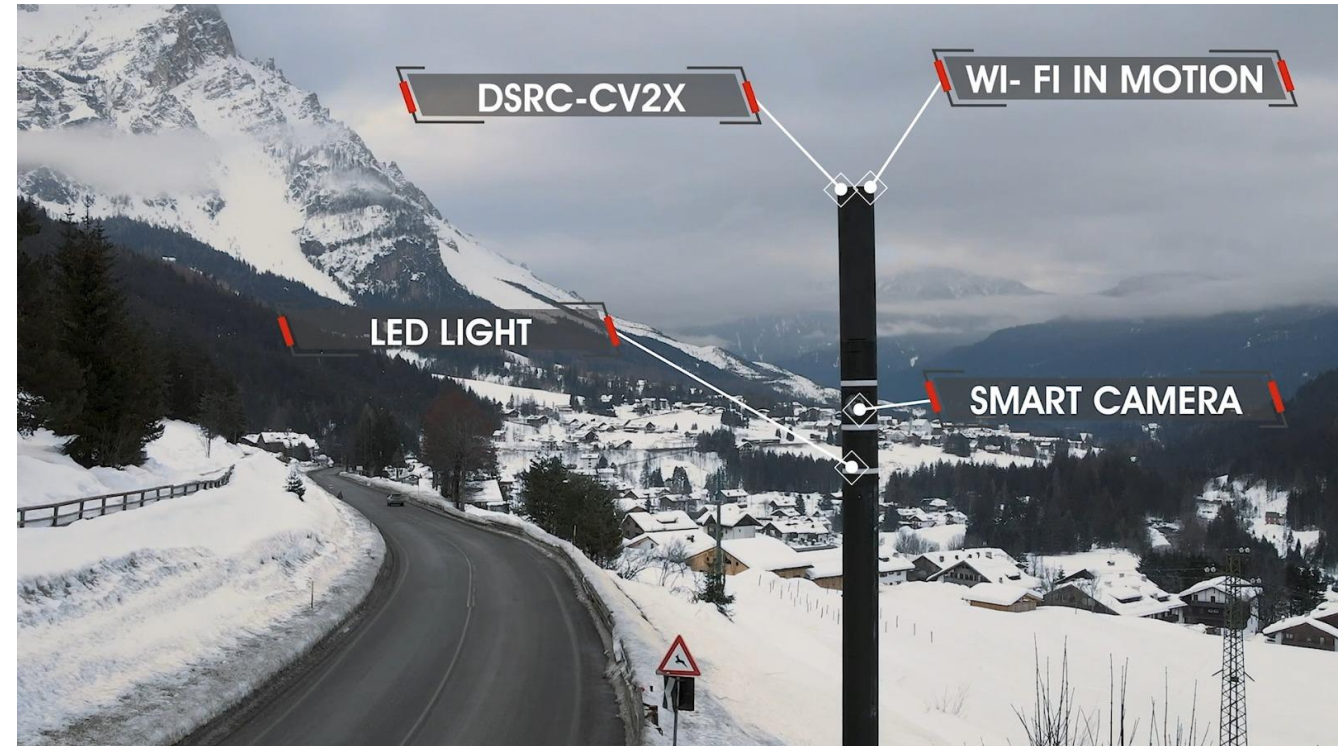
C-V2X momentum in 2020

The timeline is accelerating, particularly in Europe, US and China

	January	February			September	October	November	
EU	ETSI European specifications and standards for C-V2X completed	C-V2X devices passed European Radio Equipment Directive (RED						
US			FCC 5.9 GHz NPRM Comments Received		Work Zone and GLOSA applications complete for C-V2X deployment with VDOT, Audi and ATC			FCC 5.9 GHz Report and Order points way for 30 MHz of C-V2X-exclusive spectrum in US
China				China national goal announced: By 2025, LTE-V2X will achieve regional deployment, and NR-V2X testing will begin		Additional China national goal announcement: New energy vehicles will have intelligent network technology, and C-V2X is recognized as a fundamental technology	Another China national goal: C-V2X terminals of 50% new vehicles in 2025 and growing to 100% in 2030	
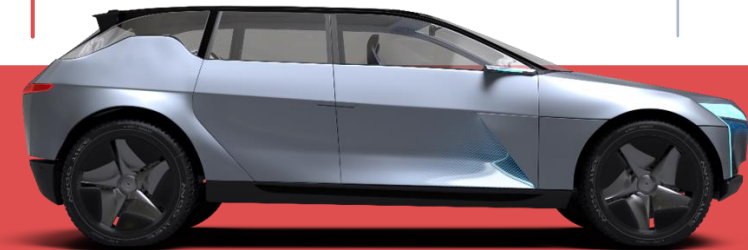
2020

Qualcomm® SA515M: 5G launch timeframe
5G in Automotive is happening now

2021　　　　　　2022　　　　　　2023　　　　　　2024

5G Only

5G, 5G Single SIM + C-V2X

5G Single SIM, 5G DSDA, 5G DSDA + C-V2X

5G, 5G Single SIM + C-V2X
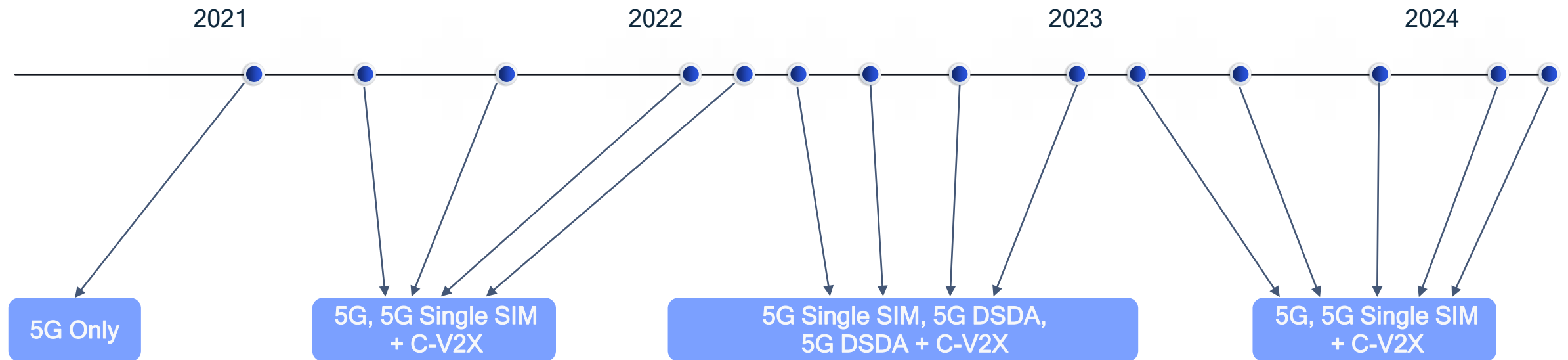
Note: SA515M 5G, 5G Single SIM + C-V2X, 5G DSDA,
5G DSDA + C-V2X **"New"** launches continue till 2025 - 2026

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Thank you

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